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ON THE

INLESS EXTINCTION OF LIFE

IN THE

LOWER ANIMALS.

A LECTURE

DELIVERED BEFORE THE SOCIETY OF ARTS, DECEMBER 18, 1884,

BY

BENJAMIN WARD RICHARDSON, M.D., F.R.S.,
VICE-PRESIDENT OF THE SOCIETY.

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Reprinted from the "Journal of the Society of Arts," December 26, 1884.

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ON

THE PAINLESS EXTINCTION OF LIFE IN THE LOWER ANIMALS.

During the latter part of last and the early part of the present year, I constructed at the Dogs' Home, Battersea, at the request of the committee of that institution, a lethal chamber for the painless extinction of the life of the animals which have, of necessity, to be destroyed there. I put the process first into operation on Monday, May 15, by subjecting thirty-eight dogs to the fatal narcotic vapour. They all passed quickly into sleep, and from sleep into death. Since that time, up to the present time, a period of seven months, the lethal chamber has been regularly in use. From 200 to 250 dogs per week have been painlessly killed in it, or a total of nearly 7,000.

The results of this procedure have been so exceptionally large, and so entirely practical and successful, the time has now come when they ought, I feel, to be brought fully into public record before this Society. I say specially this Society—the Society of Arts—because it has become by age and by nature, in England, the happy hunting ground of happy inventions, a kind of literary record office, in which the scholar of the future will find some notice of almost every discovery and mechanism which has in our time been constructed for the benefit of man and of his humble companions of the lower creation.

In this lecture I shall deal with four subjects:—

The history of the lethal process.

The lethal process in its present application.

The relation of the lethal process to other processes having the same object.

The extension of the lethal process to the slaughter of animals intended for food.

THE HISTORY.

The history of the lethal process, for extinguishing the lives of the lower animals, may be very briefly told. It follows, as a natural and practical result, upon the process of anæsthesia for the human subject about to undergo a surgical operation without feeling the pain of the operation. It is, in fact, such anæsthesia, but with this difference, that whereas in ordinary anæsthesia for an operation, the operator allows the subject who has been narcotised to return from his deathly sleep into the communion of life, in the case of the lower animals placed in the lethal chamber, the administration of the anæsthetic is sustained until the induced artificial sleep becomes the veritable sleep of death. In about one instance in three thousand it occurs, by accident, to man under chloroform that he dies in the same way. From the borrowed semblance of "shrunk death" he passes, usually, without a struggle, when the sad accident occurs, into actual dissolution.

The thought of applying the anæsthetic method to the painless destruction of the lives of the lower animals, and the first accomplishment of it, came from myself, and dates back as far as the year 1850.

In that year, I constructed at Mortlake, where I was then starting in practice, a small lethal chamber, to which my neighbours would frequently bring animals which they wished to have killed. In 1854, I began to illustrate this mode of painless death, and from that time up to 1871, I never allowed the subject to rest. In 1871, I brought it formally before the Medical Society of London, at the opening meeting of the 99th session, in a paper, afterwards published separately, entitled "Note of a Preliminary Research to Discover a Practical Method of Killing Animals without the Infliction of Pain." In this paper I discussed other modes than the lethal, to which I will refer under the third head of the present lecture.

About this same time I made, through Mr. Colam, a communication to the Royal Society for the Prevention of Cruelty to Animals on the same design, and suggested a mode for killing painlessly dogs and cats that were wounded in the streets, and I have to thank the committee of that society, and Mr. Colam, for the interest they took in my endeavours.

From that time downward to the present I have continued the inquiry, making use of all the known anæsthetic substances, in order to ascertain which was cheapest, most adaptable, most certain in action. The information, thus obtained, proved very useful when the time came for utilising it. That time came last year, when Mr. Kennett was good enough to offer the sum of £200, in order to enable the lethal method to be carried out at the Dogs' Home, where, as I have already said, it is now in operation.

THE LETHAL PROCESS IN ITS PRESENT APPLICATION.—DETAILS.

In undertaking the practical act of carrying out lethal death on the large scale required at the Home, I had to determine, in the first place, on the anæsthetic or anæsthetics to be used, and, in the second place, to construct the room or chamber in which the animals should be confined while exposed to the lethal gas or vapour.

The Anæsthetic.

I have placed on the wall a table of anæsthetics, including most that have, up to this time, been discovered, with a general outline of their respective properties and values. There is, you see, a goodly list, twenty-two in all. Out of these I selected, as shown by experiment to be the best, four.

Carbonic oxide.

Chloroform.

Carbon bisulphide.

Coal gas.

Carbonic Oxide.—I was led to carbonic oxide, not only by reading of it, and by witnessing the effects of it as a poison when it has been breathed from coke fumes, but specially from studying its action when evolved from the fumes of the *Lycoperdon giganteum*, or common puff-ball. The fumes as thus evolved, have been employed for centuries past by the common people for narcotising bees before taking the honey from the hive. A portion of the substance being burned under the hive, the bees, inhaling the fumes, fall into a deep sleep, during which time they are unconsciously deprived of their industrious earnings. I was so struck with the perfect action of these fumes after being shown one of these experiments, that, in 1854, I introduced the fumes for anæsthetic purposes. Purified by being passed through water, they produced the most rapid narcotism, under which many operations were performed painlessly on the inferior animals. The question was the character and chemical nature of the agent in the fumes which produced the anæsthesia. The late Dr. John Snow, so well known for his immense labours on anæsthetics, and the late Mr. Thornton Herepath, one of our most promising chemists, were each separately engaged in discovering the concealed gas or vapour. Snow and Herepath ran ahead of me in the inquiry. They, simultaneously, but by quite different methods of research, arrived at the fact that the narcotic present was carbonic oxide, or the same gas as is produced during the combustion of carbon or coke in a limited supply of oxygen.

These researches led me to study the action of this gas in its pure form, and to the discovery of many curious facts relating to it. Amongst other things, I noticed that, like oxygen, it made the venous blood of a bright red colour, and that warm-blooded animals exposed to it for a long period of narcotion are rendered temporarily diabetic.

I did not, on the whole, think it commendably safe as an anæsthetic for man, but I fixed upon it at once as one of the best and cheapest of lethal agents for the painless destruction of life in the lower creation. It is the principal agent for this purpose which I have used since the date named above, 1854.

Carbonic oxide is a gas, and if quite pure is so odourless and produces so little irritation, that when present in the air, it is apt to be breathed unconsciously until the effects of it are felt. Those who by accident have been narcotised by it, and have recovered from the effects, have expressed that they had no recollection of anything whatever, that they passed into sleep in the ordinary way of sleeping, and knew no more.

The gas can be made in two easy ways. (1.) It can be made simply by passing air or oxygen over burning coke or charcoal. If air be used, the product consists of carbonic oxide, with some carbonic acid, and with the nitrogen of the air, which passes through the furnace unchanged. As the nitrogen forms four-fifths of the air, the product is, of course, very much diluted. A hundred cubic feet of an atmosphere so produced does not contain

TABLE OF ANÆSTHETIC GASES AND VAPOURS.

Name of Substance.	Elementary Composition.	Material Condition.	Gas or Vapour density H=1·	Fluid Density water = 1·	Boiling point.		Physical Qualities.
					Cent.	Fahr.	
					Deg.	Deg.	
Nitrous oxide	NO	Gas	22	...	...	...	Supports common combustion : sweet, and not irritating to breathe.
Carbonic oxide	CO	Gas	14	...	...	...	Burns in oxygen ; not irritating to breathe.
Carbonic acid...	CO_2	Gas	22	...	...	...	Extinguishes flame ; irritating to breathe.
Bisulphide of carbon	CS_2	Fluid	38	1·270	43	107	Vapour burns ; odour disagreeable unless well purified.
Hydride of methyl (marsh gas)...	$CH^3 H$	Gas	8	...	...	...	Burns air ; inodorous, not irritating
Methylic ether	$C^2 H^6 O$	Gas	23	...	...	...	Burns in air ; almost inodorous when pure.
Methylic ethyl ether	$C^3 H^6 O$	Fluid	30	...	11	52	Burns in air ; ethereal odour ; rather pungent.
Chloride of methyl	$CH^3 Cl$	Gas	25·25	...	...	...	Burns in air ; rather pungent.
Bichloride of methyline	$CH^2 Cl^2$	Fluid	42·5	1·320	40	104	Vapour burns ; pungent odour.
Chloroform	$CH Cl^3$	Fluid	59·75	1·480	61	142	Vapour extinguishes flame ; pungent odour.
Tetrachloride of carbon	$C Cl^4$	Fluid	77	1·560	78	172	Vapour extinguishes flame ; odour fragrant, not pungent.
Hydride of ethyl	$C^2 H^6 H$	Gas	15	...	...	...	Burns in air ; inodorous.
Ethylic ether (absolute ether) ...	$C^4 H^{10} O$	Fluid	37	·720	34	93	Burns in air ; pungent to breathe.
Chloride of ethyl	$C^2 H^5 Cl$	Fluid	32·25	·921	11	52	Burns in air ; ethereal odour ; rather pungent.
Ethylene (olefiant gas)	$C^2 H^4$	Gas	14	...	...	...	Burns in air ; pleasant to breathe.
Bichloride of ethylene (Dutch liquid)	$C^2 H^4 Cl^2$	Fluid	49·5	1·247	80	176	Vapour burns ; ethereal odour ; rather pungent ; smoky.
Chlor-ethylidene	$C^2 H^4 Cl^2$	Fluid	49·5	1·174	64	147	Vapour burns ; ethereal sweet odour ; pungent.
Bromide of ethyl (hydrobomic ether	$C^2 H^5 B^2$	Fluid	54	1·400	40	104	Vapour rather pungent, but pleasant.
Hydride of amyl	$C^5 H^{11} H$	Fluid	36	·625	30	86	Vapour burns in air, inodorous when pure.
Amylene	$C^2 H^{10}$	Fluid	35	...	39	102	Vapour burns in air ; pungent ; smoky.
Hydrocyanic acid	$HC N$	Fluid	...	·705	26	70	Vapour painful to breathe ; special ; suffocating odour.
Coalgas	...	...	...	...	...	...	Gas at first slightly irritating, but quickly narcotic.

more than 15 per cent. of the gas. Such an atmosphere is, nevertheless, very deadly, because the nitrogen, entirely negative, has no power of sustaining life. When oxygen is used alone in limited quantity the gas is turned out practically pure. By either mode—by common air or oxygen—one pound of charcoal should yield 31 cubic feet of the lethal gas, assuming that the combustion is correctly carried out.

(2.) The second mode of making the gas is by passing carbonic anhydride, still commonly called carbonic acid, over red hot charcoal. The charcoal in this instance is placed in a tube, into which the carbonic acid, CO^2, can flow. The tube is put into a furnace, the charcoal is made red hot, and while in this state the carbonic acid passes over it. The carbonic acid is thus deprived of one part of its oxygen by combination of oxygen with the heated carbon, and carbonic oxide escapes at the exit of the tube. The gas thus formed is practically pure, and is very deadly. If even a little carbonic acid does pass over in its free state, the lethal action is sustained, carbonic acid being itself a gas destructive to life.

Chloroform. — I was naturally led to chloroform, by reason of its common use as an anæsthetic. There is no anæsthetic more certain in its action, and none more certain to kill if it be administered in a determinate manner. Administered even with skill, so as not to kill, it proves accidentally fatal about once in 2,500 times, and so soon as air is charged with over 5 per cent. of its vapour, it is not breathed without danger. Death from it is very determinate when it occurs, and seems to be entirely painless.

The vapour of chloroform does not burn. On the contrary, it extinguishes flame. If we plunge a lighted taper into a jar through which the vapour of chloroform has been diffused, the light is at once extinguished. I shall show, in the sequel, that this has a certain useful bearing on the subject now before us, apart from the matter of fatal narcotism.

Chloroform, being purchaseable as a chemical fluid, I need not refer to its manfacture. When we use it for narcotism, we merely diffuse the fluid into the state of vapour, and make provision for the vapour to be absorbed by the lungs of those subjected to it. It produces little irritation when breathed.

Bisulphide of Carbon.—The bisulphide of carbon is a very rapidly-acting anæsthetic. It produces narcotism, in fact, almost as quickly as carbonic oxide, and with less muscular commotion. The vapour of it burns in air if a light be brought near to it, but when its vapour is mixed with that of chloroform, this danger is avoided. It is bought as chloroform is, in the fluid state, and can be obtained, therefore, from the chemist directly, ready for use, by diffusion of its vapour. It has one immense advantage, that of being excessively cheap; and it has one great disadvantage, that of being excessively unpleasant in regard to its odour, unless it be most carefully purified by repeated distillations. Combined with chloroform, with which it mixes freely, the peculiar odour is largely reduced, and by pouring the mixture over chloride of lime, is almost entirely removed. For this reason, together with that relating to the difficulty of combustion of the combined vapours, I have used largely in these researches the mixture of chloroform and carbon bisulphide. The combined vapours produce also a singularly good antiseptic atmosphere. Specimens of the chloroform-bisulphide compound are on the table.

Coal Gas.—Common coal gas is one of the most potent of narcotising gases. I pointed this fact out in the very early days of anæsthesia. The gas is a compound of four gases, three of which are excellent narcotics, and one a negative gas. It contains 47 per cent. of hydrogen, 42 of marsh gas, 3 of heavy hydrocarbons, and 8 of carbonic oxide. All these gases are anæsthetic in their action; marsh gas is one of the best, and carbonic oxide is one of the quickest; but they are all explosive.

For the lethal purpose, nothing could possibly surpass coal gas. I put it freely to the test, and found it was all that we could desire. In an atmosphere containing 25 per cent. of this gas, an animal goes to sleep in from two to three minutes, and dies asleep as easily as in any narcotic vapour or gas whatever. The gas is always at hand, and for the present purpose is the cheapest and readiest of all. Used in the lethal chamber at Battersea, 100 dogs could be put painlessly to death at the cost of a shilling, and without any more trouble than that of turning on and off the gas.

Under such circumstances, it seems absurd to think of going any further for a narcotic agent. And yet it is necessary, at all events, when a large lethal chamber is wanted, on account of the danger from explosion. I feel so sure that an accident by explosion would occur from the frequent use of the gas in this manner, that I dare not undertake the responsibility of recommending it, except on a smaller scale, which has yet to be considered. A man smoking his pipe near the chamber, or carrying a light, or striking a match, might lead to the accident, or the spark from the friction of the wheels of the cage carrying the animals with the tram beneath them, and on which they rub, might cause the accident.

I hoped at one time that I had overcome this risk by the very simple expedient of letting the gas pass into a chamber through chloroform. The vapour of chloroform mixing with the gas would, I believe, prevent explosion, even if a flame were introduced. I therefore combined the gas with the chloroform, and found in the combination not only a splendid narcotic, but apparently a safe one in regard to explosion. I was disappointed. I narcotised an animal to death in a mixed atmosphere of coal gas and chloroform, and that both easily and safely. The chamber containing the animal was left for three hours, and at the close of that time the gas in it was not explosive, the vapour of the chloroform controlling the combustion. But the following morning, on striking a light in the chamber, the gas took fire with considerable force. During the coldness of the night, the vapour of chloroform had condensed, and left the gas free.

After this experience, I gave up the idea of using coal gas on a large scale. I think it may be useful in a small apparatus under some circumstances, but I would not, while admitting its many advantages, dare to recommend it as of general application.

All things considered, I was led to conclude that carbonic oxide was the best narcotic agent to employ, combining it with chloroform or carbon bisulphide if that should prove necessary. Deciding on this point, the next question was how to manufacture the carbonic oxide so as to bring it into practical use on the easiest as well as the largest scale.

I designed originally for the trial at Battersea to erect two large reservoirs, to set up an apparatus for the generation of carbonic acid, and a furnace by which this gas could be transformed into carbonic oxide. By making the carbonic oxide in this way, and charging the gas-holders with it, it would be at hand at all times to be passed into the lethal chamber.

There were difficulties in the way of carrying out this design. The first of these were the expense and the skill required to work the apparatus. The reservoirs alone would have cost a hundred pounds, and when fixed would have taken up a great deal of room; a skilled man would at the same time always be wanted to charge them and keep them in proper order.

These difficulties led me to keep to the original plan of a simply constructed stove, in which the gas should be made by burning charcoal. Here, however, when I got into experiment, I found several new difficulties which had to be removed.

The burning of charcoal in an ordinary stove produced sufficient of the gas, but the heat of the gas was such as to demand a means of cooling it before it should enter the chamber. There was also produced in the combustion, so much vapour of water, that the experimental small chamber with which I first manipulated was charged with steam, which condensing, left the walls of the chamber loaded with water, a condition most unfavourable to narcotic action, and destructive to the walls of the chamber itself.

While studying the best means of overcoming these objections, and after failing to overcome them by several methods, I luckily recalled Mr. Clark's condensing-stove. This stove, with which I have no doubt most of you are conversant, is a most ingenious invention. The fumes proceeding from the combustion in the furnace, first ascend and then descend through two lateral columns, to escape by a tube directed over a trough or saucer. A large quantity of water vapour is in this way condensed, and is collected at the base of the stove, together with substances, derived from the combustion, which are soluble in water. Here, with a little modification, was what I wanted. To adapt the stove to my purpose, I got Mr. Clark to make a charcoal furnace over a gas-burner, so that, when the charcoal was laid in the furnace, it could be instantly set alight by merely turning on and lighting the gas, letting the flames of gas play through the charcoal. Next I got him to make a large condensing cistern beneath the stove, with an opening from it to convey the carbonic oxide by a tube into the lethal chamber, and with a tap, by which the condensed fluid could be drawn off. The arrangement answered straight away, if I may so say. The immediate combustion of the charcoal by the gas, yielded very nearly the theoretical value of the product, carbonic oxide. The gas was deprived of water by the condensation; it was delivered over to the chamber with a steadiness sufficient for all practical necessities; it was cooled without any other artificial means, so as never to raise the chamber above summer heat; it was produced cheaply; and it afforded such simple action, that any workman could at once learn to use it. It is just to say that the immediate success which has followed my efforts has been much expedited by the use of the Clark condensing-stove.

Another useful result springing from the employment of this stove was, that it enabled me to diffuse other narcotics into the chamber, by merely allowing the warm gas proceeding from the stove to pass over a porous surface, charged with the narcotics, on its way into the chamber. So much for the narcotic to be used, and the production of it. I have now to pass to the method of applying it.

THE LETHAL CHAMBER.

To apply the narcotic gas or vapour, it is necessary to have a closed place in which the animals are exposed to the narcotic, and another place in which they are collected preparatory to being subjected to the narcotism. This implies what I have called the lethal chamber, and a cage.

At Battersea, it was necessary to have an apparatus large enough to narcotise as many as one hundred dogs at a time. It was, therefore, essential to have a large lethal chamber, and one that was strong and effectively constructed. I noted down at the beginning the following requirements, all of which I had calculated out of a series of preliminary studies, and constructed on a small working scale.

1. The chamber, of whatever substance built, must be so constructed that its interior shall not be subject to great variations of temperature. This I knew to be very important, since in observing the action of narcotic vapours on the human subject, I had learned that humidity and cold materially interfere with their quick action, while dryness and warmth favour such action. In a lethal receptacle, such as was being constructed, there could be no certainty whatever, unless the temperature and dryness were at all times uniform.

2. It was necessary so to construct the chamber that sufficient but not an excess of room should be allowed in it for the expansion of the gases introduced. It might seem at first sight, and before inquiry was instituted, that the more the space within the chamber was reduced, the quicker would be the effect. This, however, is not practically the fact. In order to secure perfect diffusion of the narcotic atmosphere, the space to be filled with it must be about one-eighth greater than is absolutely required for a cage, fully charged with the animals that have to be killed.

3. Much care is required in connecting the stove with the chamber, so as to make sure of equal diffusion of the gases or vapours through the enclosed space. Unless this equal diffusion is rendered effective, some of the animals are more exposed to the vapours than others. and the effects are irregular, which is as bad a result as could possibly be obtained.

4. It was essential to provide that a sufficient quantity of the narcotic should be introduced before and for a brief period after the introduction of the animals.

5. It was requisite to invent a plan by which the chamber could be kept completely closed until the precise moment when the animals have to be introduced, then instantly opened for the introduction, and as instantly closed after the introduction. It was equally requisite to guard the entrance into the chamber, so that the men employed in pushing in the cage should be protected from the vapour. A method had also to be adopted by which it could be known when all the animals had ceased to breathe.

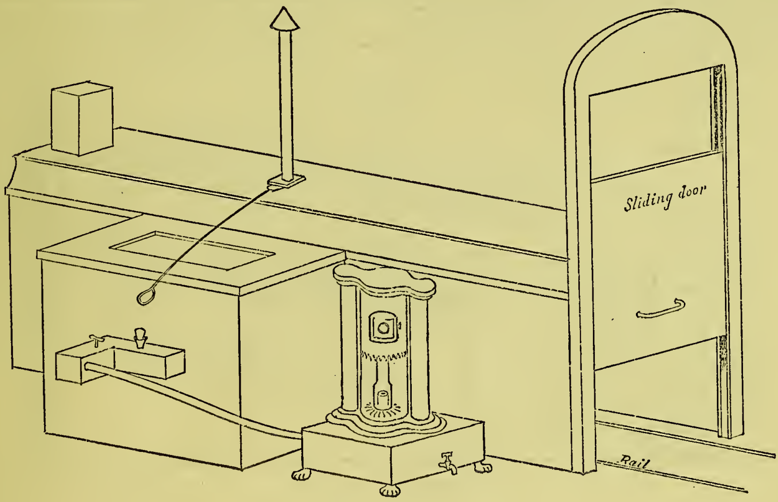
To meet the first of the above-named conditions, I constructed the lethal chamber (the outline of which is shown in Fig. 1, p. 9) of well seasoned timber, making every part of it a double wall, and filling the interspace closely with sawdust. The plan has answered all my expectations, and, with wood as the material for construction, I doubt if it can be improved upon. Should iron ever be used, and I can imagine that it is sure to be, it will be essential to have a double wall, and to fill up the interspace with a layer of Croggon's felt, an inch in thickness, or with the slag felt which was brought before the notice of this Society when I was delivering the Cantor course on the preservation of animal substances. Every part of the construction ought to be, in this manner, double lined. Should the chamber be built in brick, the wall should be of 9-inch thickness, and of glazed brick in the interior. I am of opinion that a well-built brick chamber would answer excellently well. The roof of such a place should either be an arch of brick, or iron, or wood, closely covered with felt. An inner lining of wood, covered with felt, and overlaid with galvanised iron, would be very effective.

In order to obtain the slight excess of space which was wanted to insure diffusion, I formed on each side of the chamber an extra space, which I call a pocket. The spaces, one on each side, were at first too large, and I had to reduce them, from the inside, to the size I have already indicated as the best. They are in the centre on each side, and stand out as aisles from a central nave.

In order to secure quick and equal distribution of the vapours through the chamber from the stove, I let the gases in at first from the top, under the impression that the gases, being heavier than the atmosphere, would be made to pass with greater rapidity into all parts. Theoretically, this view is correct; but as it became necessary to have two floors or tiers to the cage, I was obliged, in the end, to let in the gas half way down the sides of the chamber. By using two stoves, one on each side, this method of introduction was both convenient and effective; I do not think it could be better, however altered. To remove the common air, an opening, with a shaft of ten feet, was made in the roof. The shaft has a bore of three inches, and has a cap at the top, in order to prevent down currents of air. At the foot of the shaft is a damper, which can be opened and closed at pleasure. The directions to the managers are, to open the damper when the stove is first lighted, and let it remain open for half-an-hour; then to close it partly for another half hour, and after that to close it entirely, and not to re-open it until the chamber is again required.

To meet the fourth necessity, a plentiful supply of the narcotising vapour, two stoves have been connected with the chamber, each capable of burning two pounds of charcoal per hour, and giving up the products of the combustion into the chamber. At first—guided by the general, but not quite correct, impression as to the extremely poisonous qualities of carbonic oxide—I was content with one stove, but found it not quite sufficient, for although it delivered fifty cubic feet of the gas per hour, it acted too tardily to suit my wishes. I therefore added a second stove, which was abundantly sufficient.

Fig. 1.



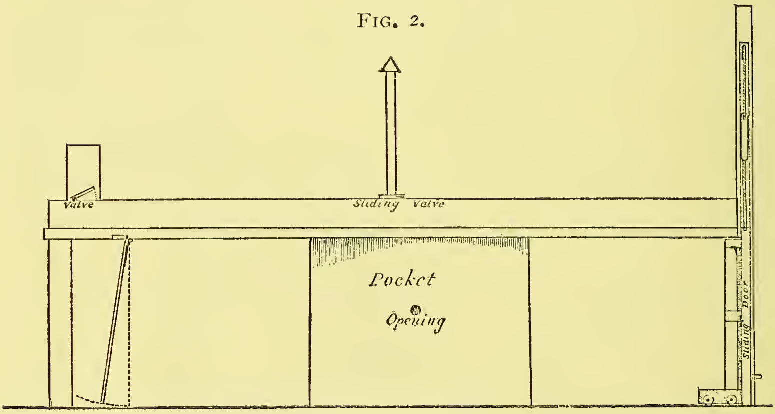
The Lethal Chamber.

To make the narcotic effect still more certain, and to keep the chamber at all times lethal, I made an extra provision. At the two points where the tubes from the stoves enter the chamber, I have interposed two strong boxes made of elm, and covered with thin lead. These boxes, which are 18 inches long, and 4 inches broad, are filled loosely with the porous burnt loam, known as Verity's patent gas fuel, an excellent substance for filling a grate where coal gas is burned instead of fuel. This substance is so porous, it takes up narcotic fluids most readily, holds them in its pores, and gives them up in volumes of vapours when warm gas is passed over it. Into the boxes closed in with this fuel there is a funnel, opening at the top, for supplying the fluid, which can be shut with a stopper; and at the end of the box, standing out at a right angle from it, is a continuous section, in which there is a large tap, for regulating the currents of gas from the stove.

When the stoves are in action, the tap is turned on, and the gases from the stove pass through the boxes over the patent fue into the chamber. Nothing more is done until just before the time when the animals in the cage are to be introduced. Then ten fluid ounces of an anæsthetic mixture, consisting of equal parts of methylated chloroform and carbon bisulphide, are poured upon the fuel through the openings in the top of the little boxes, the openings being immediately closed. After the animals are in the chamber, ten ounces more of the same mixture are added, and if, after three or four minutes, any of the narcotised animals are still breathing, ten or twenty fluid ounces more are poured in. This is not often necessary, but, for reasons which will be explained, it is occasionally.

In pushing the charged cage into the chamber, there is naturally a very great displacement of gas or vapour within. The cage has a cubic dimension of 160 cubic feet, and the chamber, with the side spaces, is 200 cubic feet. To put in the charged cage was, therefore, equivalent to displacing more than half the narcotic gas or vapour which it contained. As a consequence, it was necessary to provide an exit which would save strain on the walls of the chamber, and would let out a little gas without letting in common air. The task was one which called for considerable patience and trial of method. I met it at last by the plan shown in Fig. 2, which exhibits the chamber in section. Two feet from the far end of the chamber, there is suspended from the top a light hanging screen, which reaches within four inches of the floor. Behind this screen, and in the roof of the chamber, is a shaft, with a valve opening upwards. As the cage is pushed in, this screen is raised from the bottom, and the air, rushing out at the lower part, ascends behind, and escapes by the valve. The screen is so balanced, that when sufficient air has been extruded, its lower end reaches the back or lower end wall of the chamber. The screen itself thus acts as a regulating valve, and when the pressure is off, it returns to its level, letting any gas at the rear of it return towards the cage.

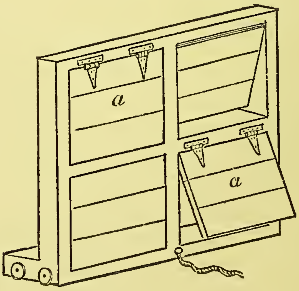
Fig. 2.



Section of Fig. 1.

To enable the operators to introduce the cage quickly, and at the same time to protect them from the action of the vapours, the following plan, also indicated in the section diagram, is adopted. The door or entrance into the lethal chamber is a slide like the sash of a window. It is placed between two strong uprights, and is balanced by a weight and pulley in each, so that it can be opened and closed with the greatest rapidity. Behind this sliding door there is placed what I call the shield or block. The shield is a framework of wood with four large metal valves, two opening inwards, two outwards. The shield is fixed on a base with four little wheels, and runs easily up or down the chamber. When the sliding

Fig. 3.

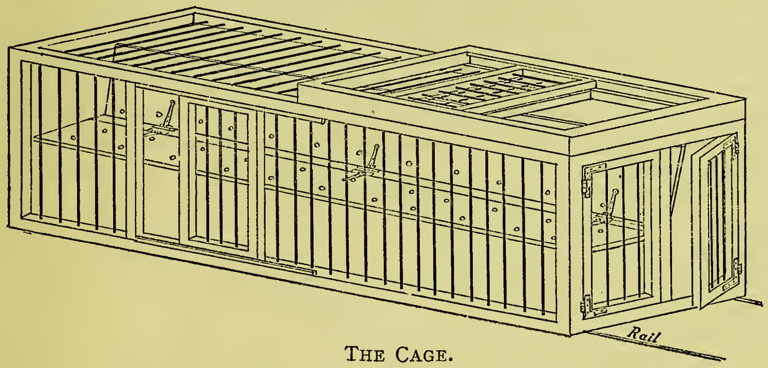


door is raised, the moveable valved shield is in position half a-foot within the chamber, and cuts off all escape of vapour. The workmen thus have time to push the cage leisurely, after the door is raised, into the chamber until the end of the cage touches the screen. This effected, they push the cage in a few seconds into the lethal atmosphere, the shield running before it, and then the door is slided down into its place. When all is nicely adapted, a very few seconds are required to introduce the cage and close the sliding or entrance door. When the cage is drawn out the screen is drawn out with it, by means of a cord which is attached to it, and which runs under the cage.

The last requirement which had to be met was the means of knowing when the narcotised animals had ceased to breathe. To get at this fact, the test of hearing was found to be the best. There is inserted into the chamber on one side a long stethoscope, made of bamboo; the mouth of this tube—of trumpet shape—is in the centre of the chamber, just above the cage, when that is in place. The outer part, or ear piece, of the tube stands out four inches on the outside, and is closed when not being used by a solid plug. On listening through this tube, the continued breathing of even a single animal can be detected, and the operators are enabled to determine if it be proper to increase the strength of the narcotic atmosphere, or to stop it.

I have now given all the necessary details of the chamber, and have only to add that it acts so well, I do not think I could improve upon it in principle if I were to construct a new one. The gases act rather rapidly on the metal pipes leading from the stoves, giving rise to some little leakage when the pressure is full on, and rendering it requisite to replace the tubes from time to time. But these are minor details which are a part of all working mechanics, and which call for nothing more than moderate attention and intelligence on the part of the men in charge, who are very soon conversant with all that has to be carried out, and with any defects that may arise.

Fig. 4.



The Cage.

THE CAGE.

In Fig. 4 will be seen best a description of the cage in which the animals are collected before being put into the lethal chamber. The cage is made of a wooden frame-work, with light iron side bars. It has two sliding doors at the sides, two at one end, and one at the top. It can be filled and emptied through these doors with great rapidity. In order to hold as many animals as possible without discomfort to them, the cage is divided into two divisions or tiers, the flooring of the upper tier being freely perforated with openings, so as to establish a communication between the upper and lower divisions, and allow a due distribution of the gases and vapours used. The cage runs on four 8-inch wheels, which are underneath it, and ply on galvanised iron rails. At the Home there are two cages, in order that one operation of painless killing may follow at once on another if that be necessary.

THE LETHAL PROCESS.

Having now given the details of the mechanism employed, I may describe with advantage the nature of the lethal process. The mode of death to which the animals are subject is that by anæsthesia, not by suffocation or asphyxia. Physiologically, there is a distinctive difference between these modes of death. Death by anæsthesia is death by sleep; death by asphyxia is death by deprivation of air. Death by anæsthesia is typically represented in death by chloroform; death by asphyxia is typically represented in drowning, or in immersion in carbonic acid gas.

When properly carried out, death by anæsthesia is by far the most certain and least violent of the two processes, although both are probably painless. The anæsthetic is as certainly proved to be painless as any such thing can be proved. In all but fatal accidents from chloroform in the human subject, we know, on the evidence of the persons who have passed through the ordeal, that there is no sense of suffering up to the extremest approach to death; and as we cannot suppose that the lower animals are more susceptible to pain than the highest animal, man, we must consider the death absolutely free of pain. An intense impression of sleep lapses into the sleep that is final.

It is worthy of record, however, that all animals are not equally susceptible to the action of the narcotic vapours. Cats, for instance, lie asleep much longer than dogs before they cease to breathe. They fall into sleep as rapidly as dogs, but do not pass so quickly into the final sleep. In the same narcotic atmosphere a cat will live twice as long as a dog, suffering nothing, and lying in deep sleep, but still breathing.

There is a difference between different animals of the same kind. Some dogs die almost instantly, in fact, as they fall asleep; others fall asleep and continue to sleep for several minutes before they cease to live. In the first observations, before I had rendered the narcotic atmosphere overpoweringly active for all cases, there were a few instances, nine in the first seven hundred, in which the animals slept on from half an hour until an hour after all their comrades had died. Finding out this strange peculiarity, I increased the amount of narcotic vapour until all succumbed very nearly at the same minute, and in the last six thousand there has been no recurrence of the prolonged insensibility. The animals are now commonly all asleep in from two to three minutes, and have ceased to exist in a further period of the same duration. In order, however, to prevent any chance of recovery from the sleep on exposure to air too quickly, the instruction is that the chamber shall on no account be opened until the expiration of one hour after the introduction of the cage. These instructions are carried out under the direction of Mr. C. Colam, the Superintendent of the Home.

By introducing some other vapours into the lethal chamber with the chloroform, the vapour of hydrocyanic acid for instance, the death, no doubt, could be made more rapid, and indeed instantaneous. To this plan there are two objections, which are, I think, final. In the first place the death would be less peaceful; in the second place, the atmosphere produced would be most dangerous to the men employed. On the whole, we could not do better than continue in the course we have hitherto followed.

A SMALLER AND PORTABLE LETHAL CHAMBER.

The success of the trial on the large scale has led me to the construction of an apparatus on a small scale, an apparatus which can be moved easily from place to place, which can be kept at different parts of a city or town, at a police station, a veterinary surgeon's, or at any institution that will take it in charge. I entered on the construction of this machine some months ago, with the conviction that I could complete it in a few weeks, and have it ready for use at the Home in cases where only one or two animals have to be destroyed. I am sorry to say that the road to success was not so easy. I have had, in fact, to construct no fewer than four chambers previous to getting what I desired in complete working form.

The difficulties have arisen from three sets of circumstances. Firstly, that in a portable machine fitted for action at a few minutes' notice, it was not possible have a fire or stove. Secondly, that in order to make the chamber adaptable to animals of different sizes, it was necessary to make it changeable in size. Thirdly, that the substance used for causing the anæsthetic death should be so cheap as to render the process generally applicable. I began by employing coal gas and chloroform, but here, again, was met by the danger of explosion. Then I proceeded to the study of the application of compressed carbonic oxide, which would answer well, but for the expense which would attach to this mode of applying it. Next, I passed to compressed gas with vapour of chloroform and carbon disulphide, but again found the cost too great. Lastly, I fixed entirely on the plan of surcharging common air with narcotic vapour by a bellows, or forcing pump, which answers exceedingly well.

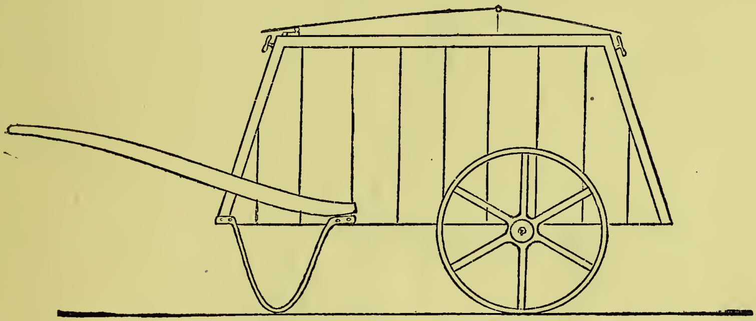
In Fig. 5 (p. 13) there is shown a view of the portable lethal chamber ready for use. It will be seen that the apparatus takes the shape of a closed truck on two wheels, and moveable like a truck or barrow. It measures 5 feet in length, is 2 feet wide, and 2 feet 6 inches high. It moves very easily, and can be managed by one man. It is constructed, like the large lethal chamber, of well-seasoned wood, in double wall, with sawdust filling up the interspace. In Fig. 6 (p. 14), the apparatus is shown in section. As will be seen, there is one large chamber, having a capacity of nine cubic feet. The chamber opens at the top by a strong lid, swung from behind, which, when brought down, entirely closes up the chamber. Under this lid there is a frame with an opening in the centre, through which baskets or cages of different sizes, and containing the animal or animals, can be let down into the larger space, and held there. This larger space is the narcotising receptacle or chamber.

At the back of the apparatus is a recess in which is placed the narcotising fluid, and the pump for forcing it into the cages containing the animals. The narcotic fluid is contained in a large strong Wolff's bottle filled loosely with Verity's fuel. The forcing pump is worked by a piston from the outside, and consists of a cylinder capable of containing one-eighth of a cubic-foot of air or gas. From the further end of the cylinder are two tubes, one of which runs into the narcotising chamber at the lower part, the other to the long tube in the Wolff's bottle below the surface of the narcotic fluid within the bottle. From the short or escape tube from the bottle is a continuous tube, terminating over the cage containing the animal. By an extra tap, coal-gas can, if desired, be let into this chamber.

MODE OF PROCEDURE.

The animal to be slept into death is placed resting on a little straw or hay, in a cage, which is then dropped into the large receptacle, the lid of which is at once closed. The handle of the piston is then moved up and down at a regular and quiet pace. As the piston is drawn out, the cylinder of the pump is filled with air from the large receptacle, and as the piston is pushed back it forces the air with which the cylinder has been filled through the narcotic fluid, a portion of which it raises into vapour and forces into the cage. Eight strokes of the piston charge one cubic foot of air with the narcotic vapour to saturation, and as there are only nine cubic feet in all to charge, a couple of minutes are sufficient to charge throughout.

FIG. 5.



PORTABLE LETHAL CHAMBER.

The animals in this apparatus pass quickly into sleep, and die not quite so quickly, but quite as painlessly, as in the larger structure.

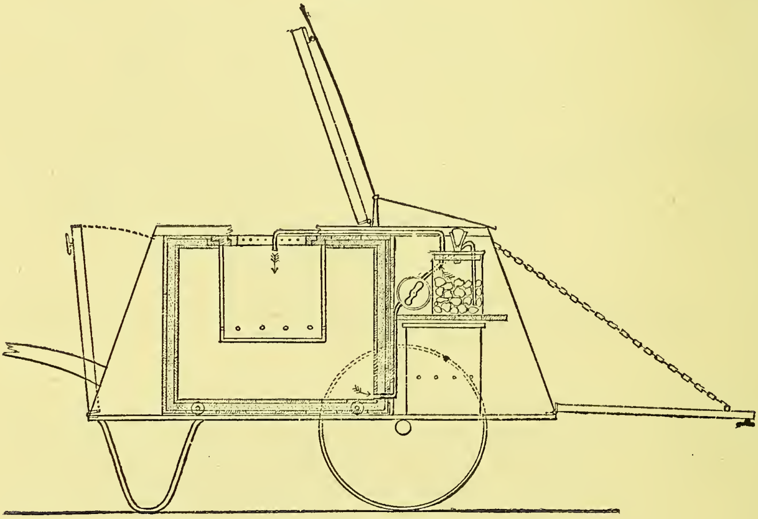
This smaller apparatus will be so complete when it is finished, that it may be wheeled from the station to a private house, if that be wanted; or it may be used in the streets for giving painless death to wounded animals. It may also, in future, be constructed at so comparatively trifling a cost, that I see no reason why every town in the country may not be in possession of one, and every small animal be spirited away in sleep.

Compared with other modes of extinguishing animal life—such as hanging, drowning, poisoning by prussic acid, shooting, stunning,—the lethal method stands far ahead on every ground of practical readiness, certainty, humanity. I cannot, however, let the opportunity pass of testifying that the method for twenty years carried out at the Dogs' Home, of killing with prussic acid, has been, by the skill and experience of the operators, brought to a great state of perfection and painlessness. The objections to it are moral and physical. It is a tax that few men can usually bear, to have every week to take scores of dogs one after another, and by force administer to each, singly, the deadly poison. Further, the poison is so deadly I look upon it as almost a miracle that no man has been accidentally killed during the process.

LETHAL DEATH FOR ANIMALS TO BE USED AS FOOD.

It will be observed that hitherto I have dwelt only on the process of lethal death in its application to small domestic animals, such as dogs, cats, and birds. I am expected to add something more in reference to the painless destruction of those animals which supply us with food; but as the Society over which I have the honour to preside, the "London Model Abbatoir Society," is about to build a model slaughterhouse, in which painless killing will form an important feature, it would be premature to enter into any details, until by careful trial the best methods have been secured. I may, nevertheless, be permitted to indicate that in respect to certain animals the painless death is quite feasible. By means of carbonic oxide, sheep can be put to sleep with the greatest rapidity before they are slaughtered. I have submitted forty sheep in this way to painless death, and found that no bad effect whatever is produced in the flesh unfitting it for food. The objection to retention of blood, so strongly felt by the Jewish people, does not obtain, the animals in the narcotic state yielding up blood just as freely as if the ordinary way, when no narcotic is used. The same process is equally applicable to swine, calves, and fowls. To oxen I do not as yet see its immediate application.

FIG. 6.



SECTION OF PORTABLE LETHAL CHAMBER.

COMPARISON WITH OTHER MODES.

I have several times been asked whether there is any other method for the painless killing of animals intended for food which might be considered by the side of the lethal method. There is only one other mode which is really worthy of consideration, and that is the mode by the electric shock. The electric shock for this purpose was first proposed by the illustrious Benjamin Franklin, some twenty years after he had proved, by the famous kite experiment, the identity of the electrical and the lightning discharge. His suggestion is supplied in a letter, which he wrote, in 1773, to MM. Dubourg and D'Alibard, in the following terms:—

"Having prepared a battery of six large glass jars (each from twenty to twenty-four pints), as for the Leyden experiment, and having established a communication, as usual, from the interior surface of each with the prime conductor, and having given them a full charge (which, with a good machine, may be executed in a few minutes, and may be estimated by an electrometer), a chain which communicates with the exterior of the jars must be wrapped round the thighs of the fowl; after which, the operator, holding it by the wings, turned back and made to touch behind, must raise it so high that the head may receive the first shock from the prime conductor. The animal dies instantly. Let the head be immediately cut off to make it bleed, when it may be plucked and dressed immediately. This quantity of electricity is supposed sufficient for a turkey of ten pounds weight, and perhaps for a lamb. Experience alone will inform us of the requisite proportions for animals of different forms and ages. Probably not less will be required to render a small bird, which is very old, tender, than for a larger one which is young. It is easy to furnish the requisite quantity of electricity, by employing a greater or less number of jars. As six jars, however, discharged at once, are capable of giving a very violent shock, the operator must be very circumspect, lest he should happen to make the experiment on his own flesh, instead of that of the fowl."

In pursuit of Franklin's idea, Mr. Collinson, an Englishman, a friend of his, endeavoured to carry out the method in practice, in which attempt he himself received a shock, which told him that electricity was no respecter of animals. The experience put an end to the proposed method until the year 1869, when I revived it by means of the large induction coil then fitted up at the Royal Polytechnic Institution. I used in these inquiries twelve large Leyden jars, the whole representing ninety-six square feet of surface. In some cases the discharge was made in the ordinary direct way, in other instances the jars were set out in cascade, on the plan devised by Benjamin Franklin. The results, as many who saw them will remember, were most striking. It was proved that the shock in cascade was the most fatal, but by both methods small animals, rabbits and birds, were killed so instantaneously that they actually remained in the exact position they had assumed at the moment the shock was given, so that it required careful examination to prove that they were really dead. In these small animals the bodies were left after the shock in a state of complete rigidity; but in a short time the rigidity subsided, and the flesh ate tender. The common idea that after death from electrical shock rapid decomposition ensues was disproved, for in all cases the bodies of the animals remained for several days free from decomposition. In another series of experiments, larger animals, sheep, were subjected to the shock, and in every instance unconsciousness immediately followed the application of the shock, the current being passed from the heads of the animals through the body to the hind extremities. The method proved very difficult to carry out in practice, for two reasons. Firstly, it was found that if the shock were so decisive that death took place absolutely, the animal would not afterwards bleed, while, if the shock were not completely decisive, the animal, during the flow of blood, evinced certain signs of returning consciousness, a phenomenon as remarkable as it was unexpected. Secondly, it was found, as in Mr. Collinson's experiments, that the administration of the shock would be dangerous to the operators, unless they took more care than could be expected from the men who are employed in the duties of the slaughter-house.

I do not despair altogether of making electricity practically useful for the extinction of life of some of the larger animals, such as horses and oxen. I have in view the construction of a porch through which a large animal may be conveyed on a truck, and during the passage through which and in no other position may receive the fatal shock. But at present the expense connected with the carrying out of this suggestion would in itself be a barrier to success.

CONCLUDING NOTE ON EXPENDITURE CONNECTED WITH THE LETHAL PROCESS.

The use of the word expense leads me, finally, to refer to a question which has been asked of me from various parts of the kingdom, relative to the expense of setting up the lethal apparatus.

In what has been done up to the present time, so much has, of necessity, been experimental, it would not be fair to calculate the expenditure connected with these first efforts as a guide to what would be the cost of a new apparatus made from the completed design. Roundly, I may say that the prime cost of the large chamber and cage, for material and labour exclusively, was, in the first instance, about £145. Since then, another cage and another stove have been added, together with iron lines, now being fitted, and with various alterations which have increased the expense. I think, however, that such a chamber, starting afresh, with all the details now understood, could be constructed for, from £150, to £175. The smaller chamber has cost, in the original working out, a larger sum in proportion, owing to the difficulties of adapting it to all requirements demanded, and the frequent reconstructions. Now, however, that it is brought into practical form, a new design from it may, I think, be constructed for £50, and if there were a demand, for even less.

The cost of charcoal for the stoves with the addition of anæsthetic fluid is, in the large chamber, a little over one halfpenny per animal when eighty to a hundred are killed at one time. When fewer are killed the expense is a little increased; the trouble and substance required being as little for a hundred as for a less part of that number.

The cost of working the little chamber is not so easily reckoned, inasmuch as the labour for moving it from one place to another will vary, while the anæsthetic required for destroying one animal would be nearly the same as for six or eight introduced at once. In any place where the small chamber is retained as a fixture, and where it is kept carefully closed, it will at all times be charged with anæsthetic vapour, and be very little more expense than the larger apparatus.

I bring my lecture to a close with the reflection that science, sometimes considered hard and unrelenting, has in this case another and different feature. If she sometimes, for the sake of man, inflicts pain on the lower creation, here she relents and does for the lower creation what she dare not do for man. By comparison, the boon is enormous. Except for the corporeal suffering, the dumb animal seems to have no pain in the prospect of death, while to man,

> "The sense of death is most in apprehension,"

and to most men is so even more acutely than the act itself. Thus he who wrote the burial service expressed the most universal of desires that at our last hour no pains of death may fall. Perchance for himself and his own kin, man, with all his ingenuity, will never see his way to escape that desire, until by a better life he wins the death by natural sleep, which nature has ordained to be as painless as his birth. Grateful, nevertheless, may he be that the power is in his hands of giving to his inferior earth-mates what he himself most earnestly prays for, Euthanasia.

The CHAIRMAN (Mr. Edwin Chadwick, C.B.) said their thanks were due to Dr. Richardson for his excellent exposition, but beyond that, for his great invention. That invention formed a large addition to the other inventions connected with the surgical and curative art which surgeons and physicians had acknowledged some years since by a large testimonial among themselves, since which time Dr. Richardson had, by his invention, largely advanced the means of diagnosis. He (Mr. Chadwick) hoped he might be pardoned for regarding the invention as a valuable addition to the beneficent functions of the police service. Up to 1838 almost the only police force were the night watchmen. He, at that time, wrote a paper to shew the expediency of superseding these inferior forces by one superior force under unity. It was the only exposition of the principle of which he was aware, and it certainly led to its adoption. Besides, the service for the repression of crime, their functions were extending for the protection of the population against accidents and calamities. They had charge of more than three thousand of people who were wounded by accidents in the streets annually, and their conveyance to the hospitals or their homes. They gave their services to the guidance of between three and four thousand bewildered and lost men, chiefly foreigners. Then fell to their care the restoration of between eight and nine thousand bewildered and lost children; they had, moreover, the care of more than twenty-two thousand bewildered and lost dogs. Those creatures who had the strongest sympathies for mankind deserved sympathy from us; and it would create a satisfactory impression from the paper read to-night, that those creatures for whom no owners could be found would, after a time, under the care of the police, receive a painless termination to their existence. Let it be known that the cost of all these and much more of annual services, such as the regulation of fourteen thousand vehicles, and the regulation of common lodging-houses, is about a penny a week per house. As a commissioner of inquiry into the organisation of police forces, he had watched the progress of such beneficent services, and he hoped that he might be pardoned for adverting to them, and expressing pleasure at the addition Dr. Richardson had made to them.

Mr. COLAM seconded the vote of thanks to Dr. Richardson, and also expressed the special thanks of the Committee of the Dogs' Home for his invention, which was of the greatest value to their institution.

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